

REMARKS

Summary of the Office Action

Claims 1 – 10 stand rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over U.S. Pre-Grant Publication 2003/0184489 by Maruyama et al. (“Maruyama”) in view of U.S. Patent No. 6,400,338 to Mejia (“Mejia”).

Summary of the Response to the Office Action

Applicants amend claims 1 and 6 to define the claimed subject matter further. Support for these amendments is found in at least the third full paragraph on page 7 of the specification as originally filed. Thus, Applicants respectfully submit that the above amendments introduce no new matter within the meaning of 35 U.S.C. §132.

Applicants request entry of the Amendment and reconsideration and timely withdrawal of the pending rejections for the reasons discussed below.

The Rejections under 35 U.S.C. § 103

Claims 1 – 10 stand rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over U.S. Maruyama in view of Mejia. Applicants respectfully submit that the combined references do not disclose or suggest all of the amended claim features, nor would a person of ordinary skill in the relevant field been prompted to combine the cited prior art in the manner claimed.

To establish an obviousness rejection under 35 U.S.C. § 103(a), four factual inquiries must be examined. The four factual inquiries include (a) determining the scope and contents of the prior art; (b) ascertaining the differences between the prior art and the claims in issue; (c) resolving the level of ordinary skill in the pertinent art; and (d) evaluating evidence of secondary

considerations. *Graham v. John Deere*, 383 U.S. 1, 17-18 (1966). In view of these four factors, the analysis supporting a rejection under 35 U.S.C. 103(a) should be made explicit, and should “identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the [prior art] elements” in the manner claimed. *KSR Int’l. Co. v. Teleflex, Inc.*, 127 S. Ct. 1727, 1741 (2007). Furthermore, even if the prior art may be combined, there must be a reasonable expectation of success, and the reference or references, when combined, must disclose or suggest all of the claim limitations. *See In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

Here, Applicants amend independent claims 1 and 6 to recite, in part, “a flexible magnetic body made of mechanically soft magnetic material having plasticity and flexibility.” The Office Action states at page 2 that Maruyama Figs. 7a and 7b teach a magnetic material that is “mechanically soft and bendable.” Applicants respectfully disagree. Applicants respectfully assert that “bendable” is not synonymous with “soft” (as the Office Action appears to suggest), and that Maruyama actually appears to teach away from a mechanically soft magnetic ribbon.

Specifically, Maruyama Fig. 7b discloses two laminated magnetic ribbons 41 and 42. As taught in Maruyama, these metal ribbons are “amorphous metal or nanocrystalline magnetism [sic]”, chosen for their soft magnetic characteristics. *See* Maruyama paragraph [0035]. The amorphous metal may be iron or cobalt. *See id.* Contrary to the Office Action assertions, the magnetic ribbons taught in Maruyama are not “mechanically soft” nor do they have “plasticity and flexibility.” Cobalt, for example, is described in Attachment 1 as “a hard, lustrous, grey metal” (emphasis added). An “amorphous metal”, as described in Attachment 2 as an alloy that resists

plastic deformation, *see* Attachment 2 at page 2 (Properties) and is known to “fail suddenly when loaded in tension.” *Id.* at 3. As shown in Attachment 3, nanocrystalline iron is known for being “far stronger and harder than its traditional counterpart.” *Id.* (emphasis added). Moreover, Maruyama paragraph [0040] teaches that in certain embodiments “laminated ribbons, together with [a] mold, are inserted into a thermostatic chamber for two hours to be hardened by heat.” *Id.* (emphasis added). Accordingly, Applicants submit that Maruyama fails to disclose or suggest “a flexible magnetic body made of mechanically soft magnetic material having plasticity and flexibility.”

Even if Maruyama were combined with Mejia with a reasonable expectation of success, however, the combined references would not disclose or suggest all the claim features of amended claims 1 and 6. The secondary reference, Mejia, is cited by the Office Action as allegedly teaching a magnetic core and wiring layer which are laminated on each other. Like Maruyama however, Mejia fails to teach or suggest the “flexible magnetic body made of mechanically soft magnetic material having plasticity and flexibility” recited in amended claims 1 and 6.

Accordingly, the cited prior art, alone or combined, fails to teach or suggest each and every feature of amended independent claims 1 and 6. Thus, even if one of ordinary skill in the art were to combine Maruyama with Mejia, a person of ordinary skill in the relevant field would not have been prompted to combine the cited prior art in the manner claimed.

Since none of the other prior art of record, alone or in any combination, discloses or suggests all the features of the claimed subject matter, Applicants respectfully submit that amended independent claims 1 and 6 are allowable. Applicants respectfully submit that dependent

claims 2 – 5 and 7 – 10 are also allowable at least because they depend from allowable claims 1 and

6. Applicants therefore respectfully request withdrawal of the rejections under 35 U.S.C. §103(a).

#

CONCLUSION

Applicants believe that a full and complete response has been made to the pending Office Action and respectfully submit that all of the stated grounds for rejection have been overcome or rendered moot. Accordingly, Applicants respectfully submit that all pending claims are allowable and that the application is in condition for allowance.

Should the Examiner feel that there are any issues outstanding after consideration of this response, the Examiner is invited to contact Applicants' undersigned representative at the number below to expedite prosecution.

Prompt and favorable consideration of this Reply is respectfully requested.

Respectfully submitted,
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Appl. No. 10/572,752
Attorney Docket No. 27304U
Response to Final Office Action mailed
May 22, 2009

ATTACHMENT 1

From Wikipedia, the free encyclopedia

Cobalt is found in various metallic-lustered ores for example cobaltite (CoAsS), but it is produced as a by-product of copper and nickel mining. The copper belt in the Democratic Republic of the Congo and Zambia yields most of the worldwide mined cobalt.

Cobalt is an essential trace-element for all multicellular organisms as the active center of coenzymes called cobalamins. These include vitamin B-12 which is essential for mammals. Cobalt is also an active nutrient for bacteria, algae, and fungi, and may be a necessary nutrient for all life.

- 1 Characteristics
- 2 History
- 3 Occurrence
- 4 Production
- 5 Isotopes
 - 5.1 Cobalt radioisotopes in medicine
 - 5.2 Industrial uses for radioactive isotopes
 - 5.3 Cobalt-60 as weapon

<http://en.wikipedia.org/wiki/Cobalt>

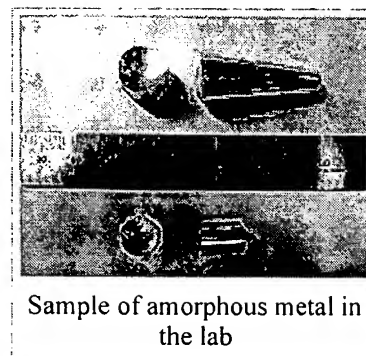
Appl. No. 10/572,752
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ATTACHMENT 2

Amorphous metal

From Wikipedia, the free encyclopedia

An **amorphous metal** is a metallic material with a disordered atomic-scale structure. In contrast to most metals, which are crystalline and therefore have a highly ordered arrangement of atoms, amorphous alloys are non-crystalline. Materials in which such a disordered structure is produced directly from the liquid state during cooling are called "glasses", and so amorphous metals are commonly referred to as "**metallic glasses**" or "**glassy metals**". However, there are several other ways in which amorphous metals can be produced, including physical vapor deposition, solid-state reaction, ion irradiation, melt spinning, and mechanical alloying. Amorphous metals produced by these techniques are, strictly speaking, not glasses. However, materials scientists commonly consider amorphous alloys to be a single class of materials, regardless of how they are prepared.



In the past, small batches of amorphous metals have been produced through a variety of quick-cooling methods. For instance, amorphous metal wires have been produced by sputtering molten metal onto a spinning metal disk. The rapid cooling, on the order of millions of degrees a second, is too fast for crystals to form and the material is "locked in" a glassy state. More recently a number of alloys with critical cooling rates low enough to allow formation of amorphous structure in thick layers (over 1 millimeter) had been produced, these are known as **bulk metallic glasses (BMG)**. Liquidmetal sells a number of titanium-based BMGs, developed in studies originally carried out at Caltech. More recently, batches of amorphous steel have been produced that demonstrate strengths much greater than conventional steel alloys.

Contents

- 1 History
- 2 Properties
- 3 Applications
- 4 References
- 5 External links
- 6 See also

History

The first reported metallic glass was an alloy ($\text{Au}_{75}\text{Si}_{25}$) produced at Caltech by W. Klement (Jr.), Willens and Duwez in 1960^[1]. This and other early glass-forming alloys had to be cooled extremely rapidly (on the order of one megakelvin per second, 10^6 K/s) to avoid crystallization. An important consequence of this was that metallic glasses could only be produced in a limited number of forms (typically ribbons, foils, or wires) in which one dimension was small so that heat could be extracted quickly enough to achieve the necessary cooling rate. As a result, metallic glass specimens (with a few exceptions) were limited to thicknesses of less than one hundred micrometres.

In 1969, an alloy of 77.5% palladium, 6% copper, and 16.5% silicon was found to have critical cooling

rate between 100 K/s to 1000 K/s.

In 1976, H. Liebermann and C. Graham developed a new method of manufacturing thin ribbons of amorphous metal on a supercooled fast-spinning wheel.^[2] This was an alloy of iron, nickel, phosphorus and boron. The material, known as **Metglas**, was commercialized in early 1980s and used for low-loss power distribution transformers (Amorphous metal transformer). Metglas-2605 is composed of 80% iron and 20% boron, has Curie temperature of 373 °C and a room temperature saturation magnetization of 125.7 milliteslas.

In the early 1980s, glassy ingots with 5 mm diameter were produced from the alloy of 55% palladium, 22.5% lead, and 22.5% antimony, by surface etching followed with heating-cooling cycles. Using boron oxide flux, the achievable thickness was increased to a centimeter.

The research in Tohoku University and Caltech yielded multicomponent alloys based on lanthanum, magnesium, zirconium, palladium, iron, copper, and titanium, with critical cooling rate between 1 K/s to 100 K/s, comparable to oxide glasses.

In 1988, alloys of lanthanum, aluminium, and copper ore were found to be highly glass-forming.

In the 1990s, however, new alloys were developed that form glasses at cooling rates as low as one kelvin per second. These cooling rates can be achieved by simple casting into metallic molds. These "bulk" amorphous alloys can be cast into parts of up to several centimeters in thickness (the maximum thickness depending on the alloy) while retaining an amorphous structure. The best glass-forming alloys are based on zirconium and palladium, but alloys based on iron, titanium, copper, magnesium, and other metals are also known. Many amorphous alloys are formed by exploiting a phenomenon called the "confusion" effect. Such alloys contain so many different elements (often a dozen or more) that upon cooling at sufficiently fast rates, the constituent atoms simply cannot coordinate themselves into the equilibrium crystalline state before their mobility is stopped. In this way, the random disordered state of the atoms is "locked in".

In 1992, the first commercial amorphous alloy, Vitreloy 1 (41.2% Zr, 13.8% Ti, 12.5% Cu, 10% Ni, and 22.5% Be), was developed at Caltech, as a part of Department of Energy and NASA research of new aerospace materials. More variants followed.

In 2004, two groups succeeded in producing bulk amorphous steel, one at Oak Ridge National Laboratory, the other at University of Virginia. The Oak Ridge group refers to their product as "glassy steel". The product is non-magnetic at room temperature and significantly stronger than conventional steel, though a long research and development process remains before the introduction of the material into public or military use.^{[3][4]}

Properties

Amorphous metal is usually an alloy rather than a pure metal. The alloys contain atoms of significantly different sizes, leading to low free volume (and therefore up to orders of magnitude higher viscosity than other metals and alloys) in molten state. The viscosity prevents the atoms moving enough to form an ordered lattice. The material structure also results in low shrinkage during cooling, and resistance to plastic deformation. The absence of grain boundaries, the weak spots of crystalline materials, leads to better resistance to wear and corrosion. Amorphous metals, while technically glasses, are also much tougher and less brittle than oxide glasses and ceramics.

Thermal conductivity of amorphous materials is lower than of crystals. As formation of amorphous

structure relies on fast cooling, this limits the maximum achievable thickness of amorphous structures.

To achieve formation of amorphous structure even during slower cooling, the alloy has to be made of three or more components, leading to complex crystal units with higher potential energy and lower chance of formation. The atomic radius of the components has to be significantly different (over 12%), to achieve high packing density and low free volume. The combination of components should have negative heat of mixing, inhibiting crystal nucleation and prolongs the time the molten metal stays in supercooled state.

The alloys of boron, silicon, phosphorus, and other glass formers with magnetic metals (iron, cobalt, nickel) are magnetic, with low coercivity and high electrical resistance. The high resistance leads to low losses by eddy currents when subjected to alternating magnetic fields, a property useful for eg. transformer magnetic cores.

Amorphous alloys have a variety of potentially useful properties. In particular, they tend to be stronger than crystalline alloys of similar chemical composition, and they can sustain larger reversible ("elastic") deformations than crystalline alloys. Amorphous metals derive their strength directly from their non-crystalline structure, which does not have any of the defects (such as dislocations) that limit the strength of crystalline alloys. One modern amorphous metal, known as Vitreloy, has a tensile strength that is almost twice that of high-grade titanium. However, metallic glasses at room temperature are not ductile and tend to fail suddenly when loaded in tension, which limits the material applicability in reliability-critical applications, as the impending failure is not evident. Therefore, there is considerable interest in producing metal matrix composite materials consisting of a metallic glass matrix containing dendritic particles or fibers of a ductile crystalline metal.

Perhaps the most useful property of bulk amorphous alloys is that they are true glasses, which means that they soften and flow upon heating. This allows for easy processing, such as by injection molding, in much the same way as polymers. As a result, amorphous alloys have been commercialized for use in sports equipment, medical devices, and as cases for electronic equipment.

Thin films of amorphous metals can be deposited via high velocity oxygen fuel technique as protective coatings.

Applications

$\text{Ti}_{40}\text{Cu}_{36}\text{Pd}_{14}\text{Zr}_{10}$ is believed to be noncarcinogenic, is about 3 times stronger than titanium, and its elastic modulus nearly matches bones. It has a high wear resistance and does not produce abrasion powder. The alloy does not undergo shrinkage on solidification. A surface structure can be generated that is biologically attachable by surface modification using laser pulses, allowing better joining with bone. [5]

References

1. ^ "Non-crystalline Structure in Solidified Gold-Silicon Alloys". *Nature* **187**: 869–870. 1960.
2. ^ Libermann H. and Graham C., Production Of Amorphous Alloy Ribbons And Effects Of Apparatus Parameters On Ribbon Dimensions, IEEE Transactions on Magnetics, Vol Mag-12, No 6, 1976
3. ^ "Glassy Steel". *ORNL Review* **38** (1). 2005.
http://www.ornl.gov/info/ornlreview/v38_1_05/article17.shtml.
4. ^ V. Ponnambalam, S. Joseph Poon and Gary J. Shiflet (2004). "Fe-based bulk metallic glasses with diameter thickness larger than one centimeter". *Journal of Materials Research* **19** (5): 1320.

doi:10.1557/JMR.2004.0176. <http://lucy.mrs.org/publications/jmr/jmra/2004/may/0176.html>.

5. ^ http://techon.nikkeibp.co.jp/english/NEWS_EN/20090610/171551/?P=1 Japanese Universities Develop Ti-based Metallic Glass for Artificial Finger Joint

Amorphous metals (metallic glasses) exhibit unique softening behavior above their glass transition and this softening has been increasingly explored for thermoplastic forming of metallic glasses. Recently, Kumar and Schroers have shown that metallic glasses can be patterned on extremely fine length scales (10-100nm). This finding opens a new area of applications for metallic glasses like, nanoimprinting, data storage, patterned surfaces for controlling cell responses etc.^[1]

External links

- "Metallic glass: a drop of the hard stuff" at New Scientist
- *Glass-Like Metal Performs Better Under Stress* Physical Review Focus, June 9, 2005
- "Overview of metallic glasses"
- *New Computational Method Developed By Carnegie Mellon University Physicist Could Speed Design and Testing of Metallic Glass* (2004) (the alloy database developed by Marek Mihalkovic, Michael Widom, and others)
- Materialstoday.com: Bulk metallic glass
- New tungsten-tantalum-copper amorphous alloy developed at the Korea Advanced Institute of Science and Technology [1]
- Amorphous Metals in Electric-Power Distribution Applications

See also

- Glass-ceramic-to-metal seals
- Materials science

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ATTACHMENT 3



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Super-hard Nanocrystalline Iron Developed That Can Take The Heat

ScienceDaily (May 28, 2008) — Researchers at North Carolina State University have created a substance far stronger and harder than conventional iron, and which retains these properties under extremely high temperatures — opening the door to a wide variety of potential applications, such as engine components that are exposed to high stress and high temperatures.

See also:

Matter & Energy

- Thermodynamics
- Materials Science
- Nanotechnology
- Civil Engineering
- Chemistry
- Inorganic Chemistry

Reference

- Metal
- Metallurgy
- Stainless steel
- Hafnium

Iron that is made up of nanoscale crystals is far stronger and harder than its traditional counterpart, but the benefits of this "nano-iron" have been limited by the fact that its nanocrystalline structure breaks down at relatively modest temperatures. But the NC State researchers have developed an iron-zirconium alloy that retains its nanocrystalline structures at temperatures above 1,300 degrees Celsius — approaching the melting point of iron.

Kris Darling, a Ph.D. student at NC State who led the project to develop

the material, explains that the alloy's ability to retain its nanocrystalline structure under high temperatures will allow for the material to be developed in bulk, because conventional methods of materials manufacture rely on heat and pressure.

In addition, Darling says the ability to work with the material at high temperatures will make it easier to form the alloy into useful shapes — for use as tools or in structural applications, such as engine parts.

The new alloy is also economically viable, since "it costs virtually the same amount to produce the alloy" as it does to create nano-iron, Darling says.

Dr. Carl C. Koch, an NC State professor of materials science engineering who worked on the project, explains that the alloy essentially consists of 1 percent zirconium and 99 percent iron. The zirconium allows the alloy to retain its nanocrystalline structure under high temperatures.

Journal reference:

Darling et al. Grain-size Stabilization in Nanocrystalline FeZr Alloys. *Scripta Materialia*, 2008; DOI: 10.1016/j.scriptamat.2008.04.045

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- MLA

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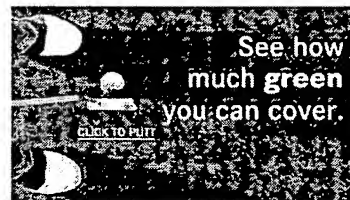
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